KUL – EXTENDED ABSTRACT SUBMISSION (presentation)

Digital game based learning and serious game for higher education

Keywords: Automation strategies, Digital game based learning, serious games, production

Abstract

Game based learning has proved to increase the motivation of learning among students. A first development of this regarding automation strategies was presented last year in terms of analog games. During the year, development towards Digital Game Based Learning (DGBL) and the use of Serious Games (SG) have been our focus. A mobile game was developed and validated in two rounds during the year and approximately 200 students in total have played and evaluated the game. The aim of this paper is to show how DGBL and SG can be used in higher education in order to explain a complex context and what can be gained regarding using the evaluation form.

INTRODUCTION

The understanding of automation strategies and to be able to choose the best solution for a given situation seems hard for students without industrial experience. There is a complex correlation between humans, physical and cognitive automation (Fast-Berglund, Fässberg, Hellman, Davidsson, & Stahre, 2013) that needs experience in order to understand. In order to understand this relation a mobile game has been developed and evaluated by approximately 200 students during 2015-2016. In higher education, the main objective of applying games is to engage learners in complex problem spaces that mimic real world situations, without importing unwanted constraints and risks of the real world (Westera, Nadolski, Hummel, & Wopereis, 2008).

There are two aspects used in this paper; Game based learning and serious game. Game Based Learning (GBL) can be described as manage complex aspects by using game mechanisms in order to increase the motivation and engagement of the once who plays (Deterding, Dixon, Khaled, & Nacke, 2011). Digital Game-Based Learning (DGBL) is closely related to GBL but with the addition that this concerns digital games (Van Eck, 2006). Serious game (SG) can be defined as the experimental and emotional freedom of active play with the seriousness of thought and problems that require it (Abt, 1987). Furthermore, these serious play activities follow an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement (Susi, Johannesson, & Backlund, 2007).

There is a big learning potential in these types of games since the future students are so called digital natives (Prensky, 2001) and therefore their preferences and abilities have also changed to be able to learn through DGBL. Through gaming, the students should be challenged to develop relevant knowledge representations and the associated reasoning and problem solving strategies (Westera et al., 2008). To this end, learners should be confronted with well-defined problems that allow multiple solutions and require the application of necessary methodologies or tools, and collaboration with fellow learners. An important impediment for such games, though, is the large efforts needed for their development.

This paper aims to present the introduction of a serious game (SG) used in higher education in order to explain a complex context within an automation context. Results shows that students are positive towards using the game as a learning tool, but few understood the meaning of the game as a SG and how it could be transferred to real life problems.

DEVELOPMENT OF THE GAME

The aim of the mobile game was that it should not exclude the theory previously presented within the course – the theory should instead serve as needed complement to the interactive processes. The complexity of the SG lies in understanding that it is very difficult to choose what automation solutions should be used in different contexts. Previously (without the introduction of the game) the students realized too late, that they did not understand how complex the choices really were – which is problematic from a teacher perspective. Figure 1 is used to understand the relations in the education.

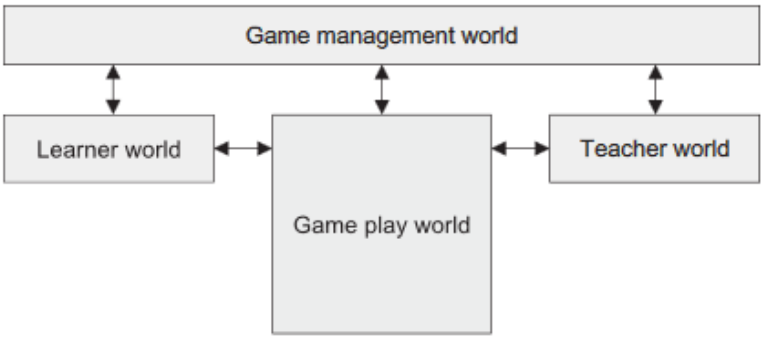

Figure 1 Subsystems and relations of an educational game environment (Westera, Nadolski, Hummel, & Wopereis, 2008).

Teacher World: Subsystem of the educational game environment which contains the teacher and its specific context.

The game has been used in four different courses (LMT108 (M3), PPU235 (Z2), PPU160 (MPPEN) and a doctoral course) within the course moment of levels of automation and automation strategies. The aim with the game is to go from level 1 (remember) to at least level 3 (apply) in Bloom's taxonomy for learning (Krathwohl, 2002) within the learning objectives related to automation strategies and ethics regarding automation. For example, to use the results from the lectures and the game to draw conclusion related to a real industrial problem. The examination has differed between the different classes, from examination questions to small surveys.

Learner world: Subsystem of the educational game environment which contains the learner and its specific context.

The different courses vary a lot in terms of real production experiences and in order to understand automation strategies and what to choose it is a great advantage to have experience. The aim of the game was to make the non-experienced students face some of the questions needed to be answered if working in industry and to be able to produce new products in an effective way.

Game play world: Context of operation defined by the rules of play and the physical and temporal boundaries of the game

For designing the game, different methods and demands were used. The MDA[1] frame work (Hunicke, LeBlanc, & Zubek, 2004) was used as design parameters in the game and as evaluation of the game.

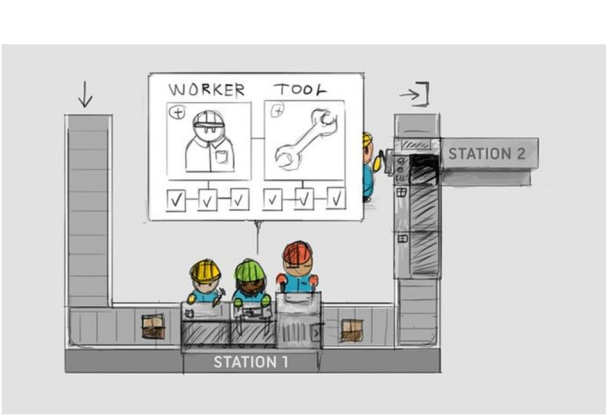

Figure 2a early design ideas of the game; 2b, finished game overview

[1] M*echanics* - is related to the system, describing the specific components of the game, at the level of data representation and algorithms. Mechanics designing the functional elements of the game, such as points, levels, leader boards, profits, Challenge, togetherness, commitment, virtual goods, etc
Dynamics - describes the real time behavior of the mechanics and how it affects the play of inputs and outputs over time.
Aesthetics - describes the desirable emotional responses evoked in the player when the player interacts with the game system. Aesthetics are very closely related with surprise, satisfaction, affiliation, etc.

Game management world: Subsystem of the educational game environment where the different game runs are arranged and coordinated

Since there is only one game in the course and this is one part of the course there is no need for a management world. If the game is developed other learning activities are added this might be applicable in the future.

EVALUATION OF THE GAME

The evaluation was divided into the three areas of the education game environment. In order to do a quantitative evaluation, a survey was sent out to the students after playing the game. The survey contained nine different questions and one area were the students could write their own comments. Two of the questions were connected to the teachers' world in terms of learning outcomes, three were connected to the learners' world and three connected to the game play world. The responders were in total N=145 (beta=80 and alfa=65), most of the comments come from the alfa evaluation. For designing the game different methods and demands were used.

Teacher World: Subsystem of the educational game environment which contains the teacher and its specific context.

To be able to evaluate the game seen from the teacher side, two questions were asked in the survey; 1) Do you think that the game is a relevant part of the course and 2) is the game a positive aspect of the course? The result in figure 3a shows that over 75 percent of the students thought that it was a relevant part of the course (over 3). The positive aspect of the course was a little higher which indicates that digital game based learning could be a good way to complement theory in a course. Figure 3b shows the improvement of the evaluation between alfa and beta version of the game. The results show an improvement on both aspects.

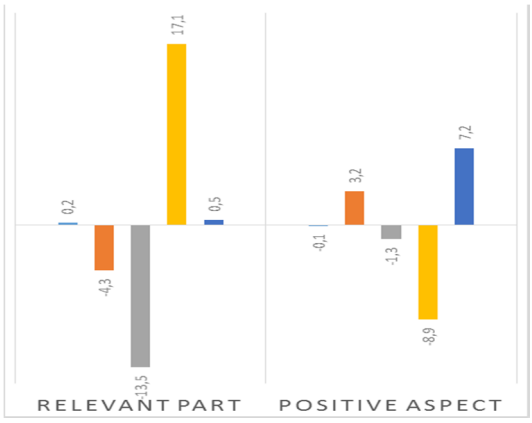

Figure 3a Evaluation of the game; relevant part of the course and positive aspect of the course; 3b differences between alfa and beta

Learner world: Subsystem of the educational game environment which contains the learner and its specific context.

The hard thing with a serious game is to make the students understand the idea with the game. This citation is a perfect example that the students has almost understood the main idea of the game but since he/she sees it as a game and not a serious game he/she thinks that the dynamics is horrific instead of really good.

> *The dynamics are horrific, it is extremely grindy since you cannot complete the game without abusing the education, and if you do that you can have so skilled workers that automation is not even required. Education and LoA being pure multiplayers leads to a weird situation where the best tool is the tool with the highest LOA per cost and it's almost always better to educate your worker than hiring a new one to increase productivity.*

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This is exactly what we want them to experience, educate the operators you already have and you do not have to hire new operators or even fully automate. This could be a perfect argument in the ethical dilemma that the robots take all the jobs.

The results from examination of the first round shows a better understanding of automation strategies and a better result of the examination of this part of the course. For the second round, the examination have not been evaluated yet so no quantitative results from examination could be presented.

Game play world: Context of operation defined by the rules of play and the physical and temporal boundaries

In order to evaluate the game play world, three questions about the mechanics, dynamics and aesthetics were asked. These were questions were the students could add their own text.

- *The dynamics of the game is good as it describes the dynamics of a production system in a good and realistic way*

- *The aesthetics was good. I got really surprised for example when products were put into play in a later time, when almost all my products were fully produced there came some more which really tested my production system and made me develop the system so that I could produce faster to assemble the products in time*

Overall the students were positive to the game, but many of them thought that the point system was hard to understand.

CONCLUSION

The students were positive to have a game as a learning activity in the courses but more explanation about the goal with a serious game is needed in order to fully understand the potential and to be able to transfer the discussion of automation to real life application. The game will continue to evolve and the next step is to bring in more mechanics into the game structure. As a next step, the game will be used and validated within industry. A comparison between students and industry will be interesting. As a complement to the game, short tutorials will be animated and used in the courses so that the flipped class room idea can be taken one step further.

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